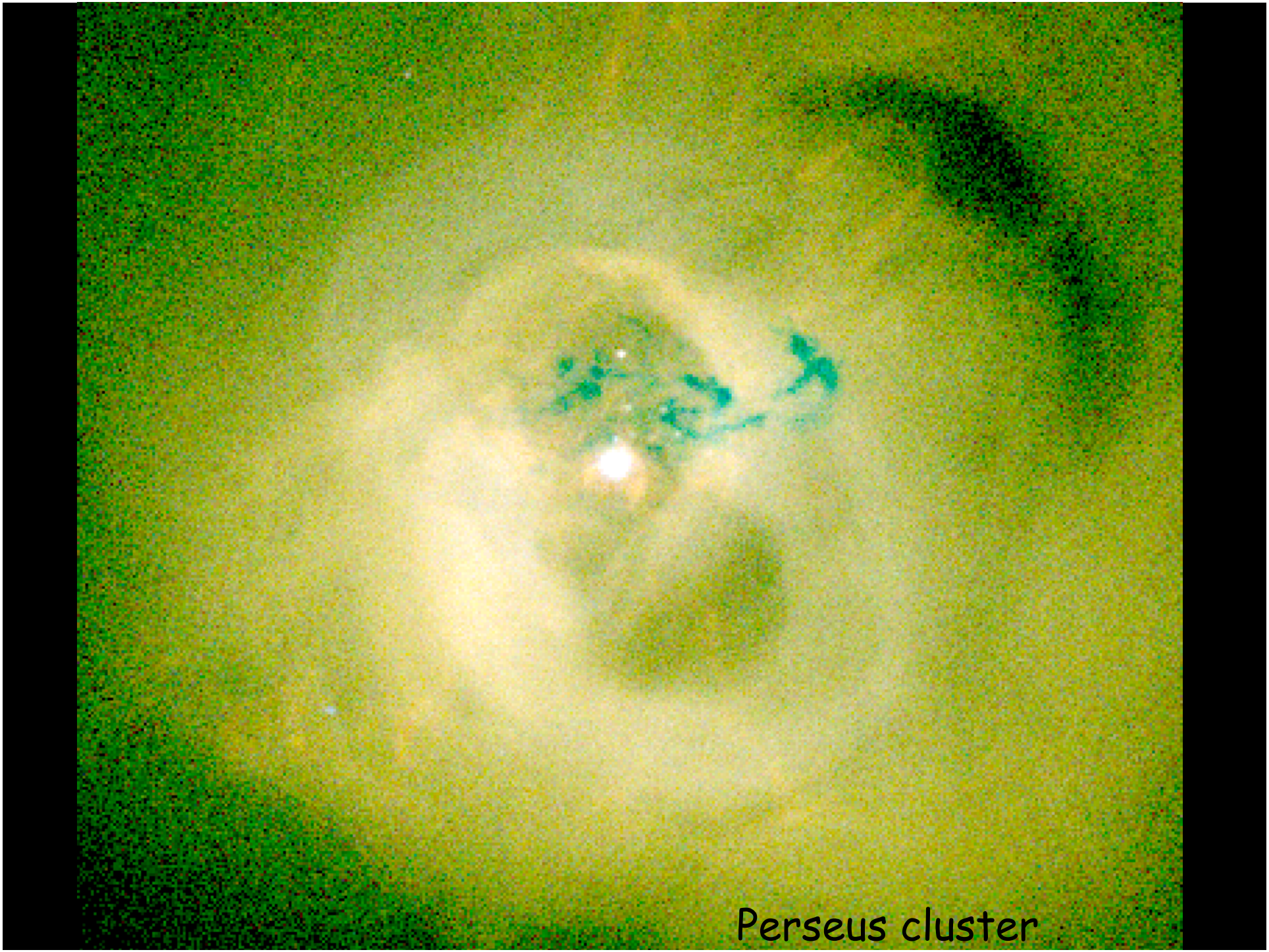
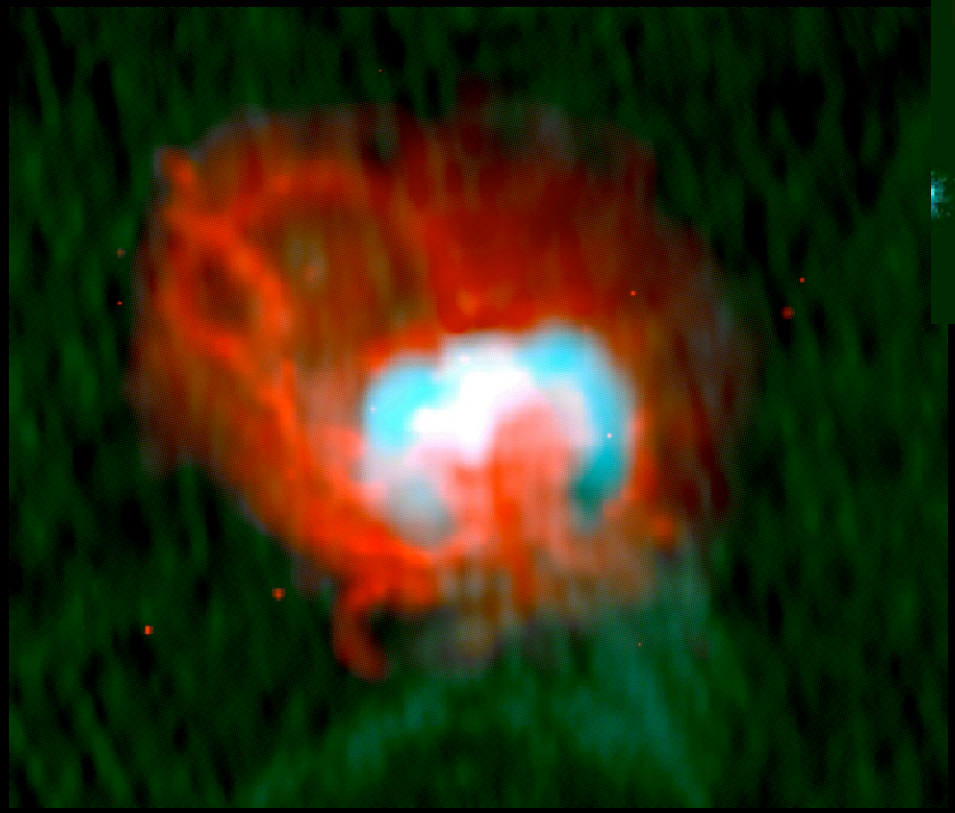
XEUS / CON-X

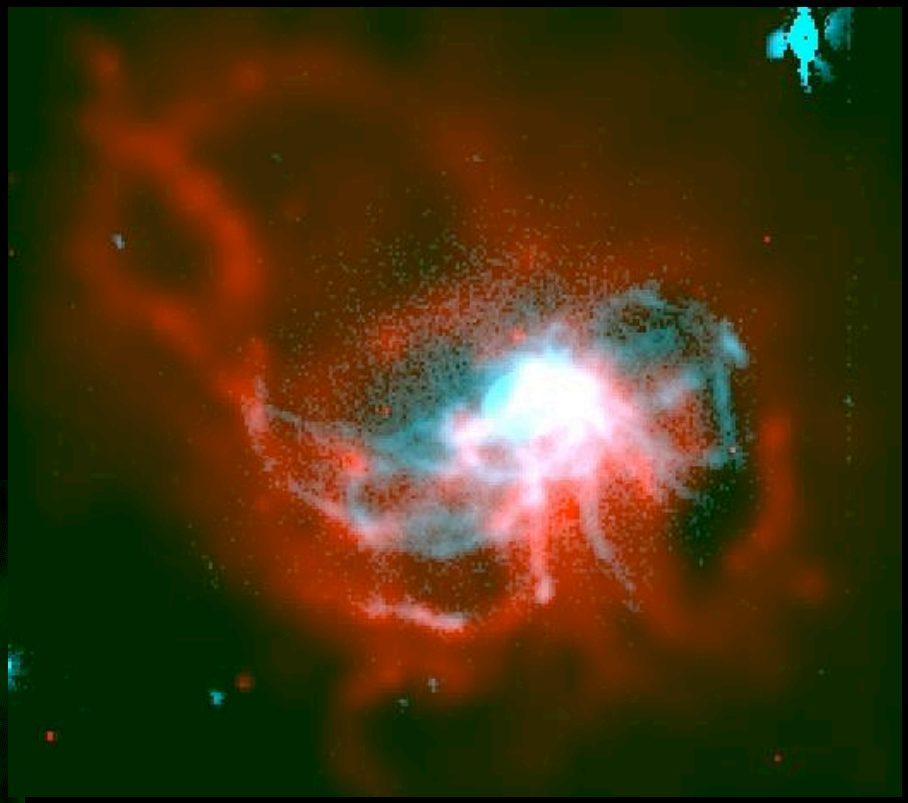
Accreting Massive Black Holes

AC Fabian IoA Cambridge UK


Perseus cluster

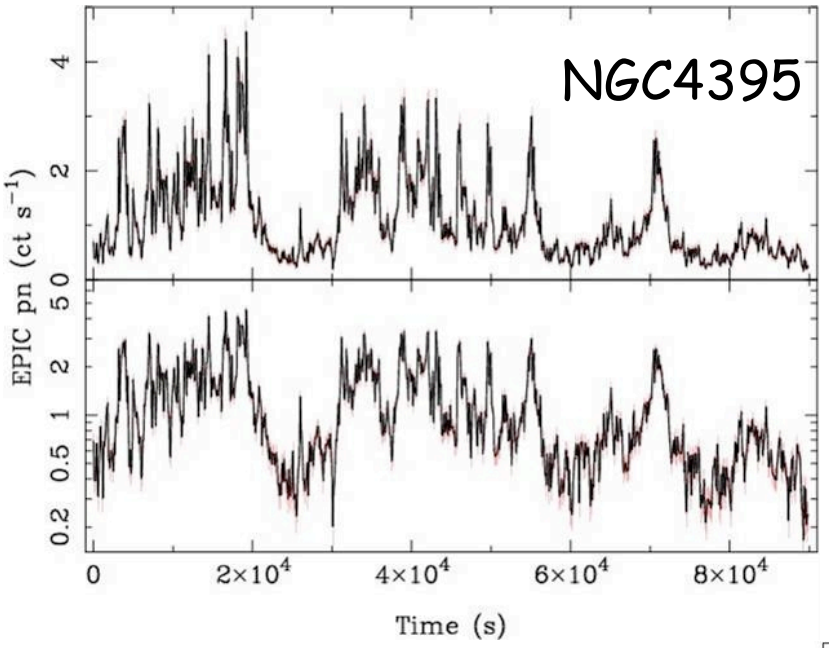
Centaurus cluster
X-ray - radio

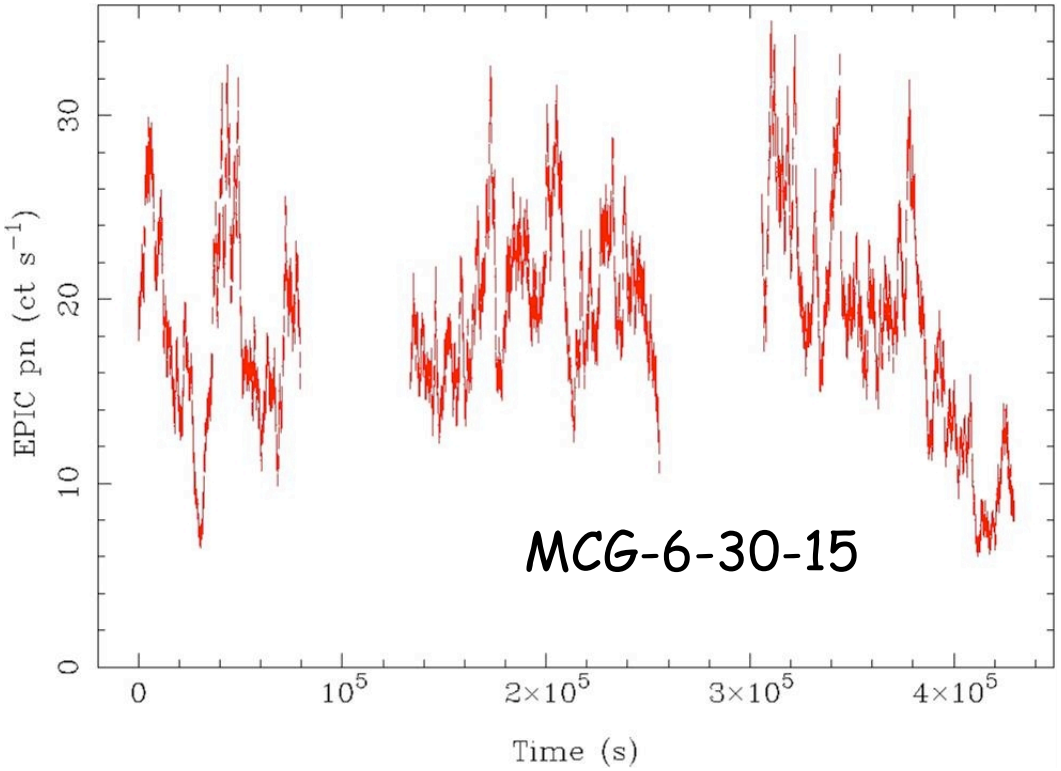




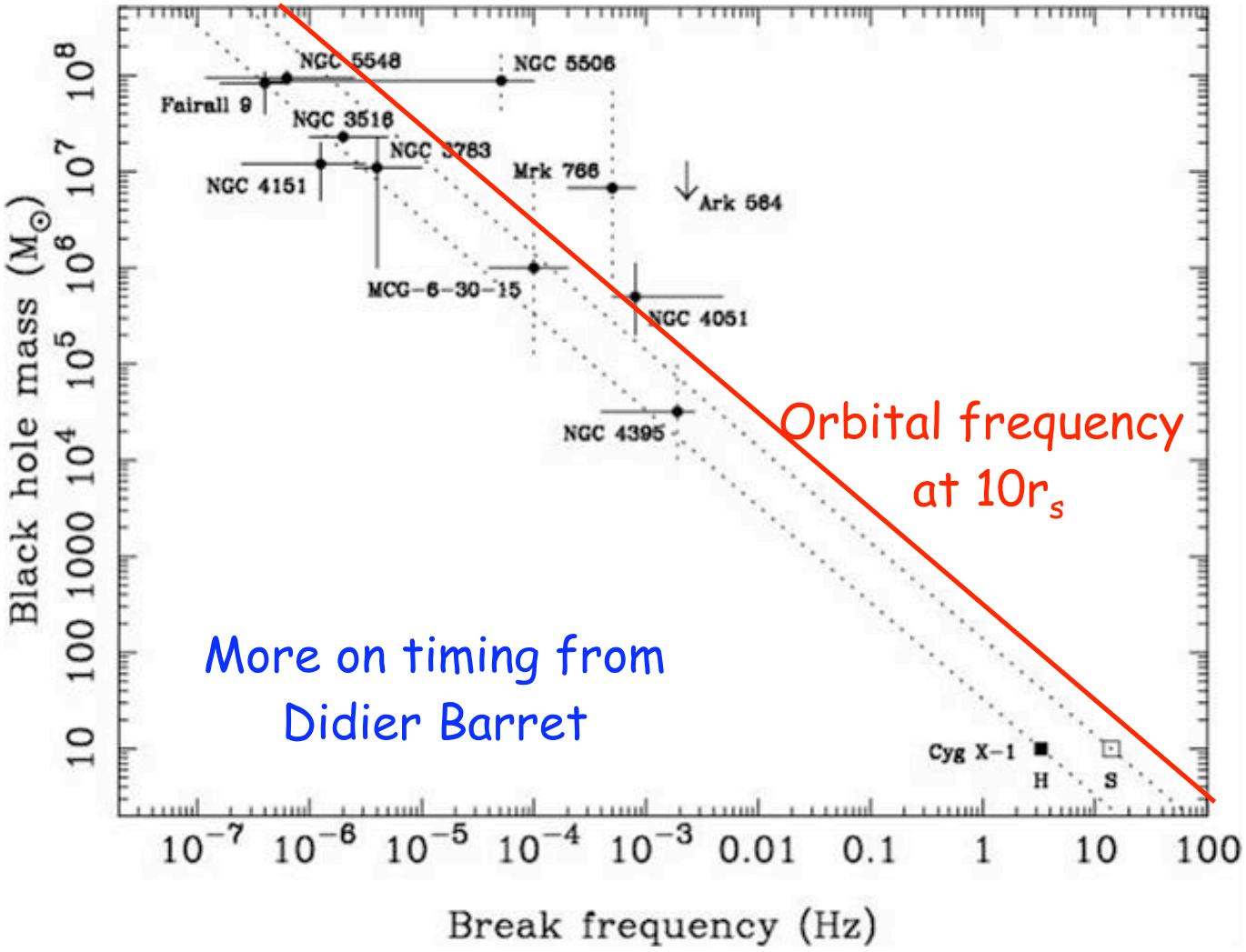
X-ray - H_

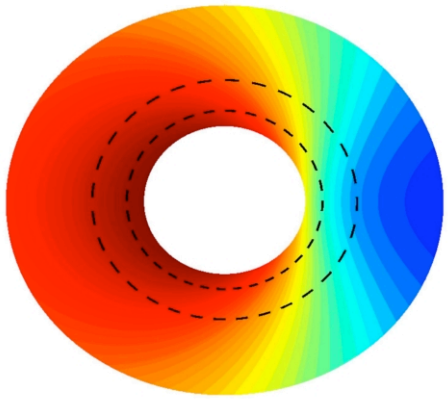
Rapid variability in AGN

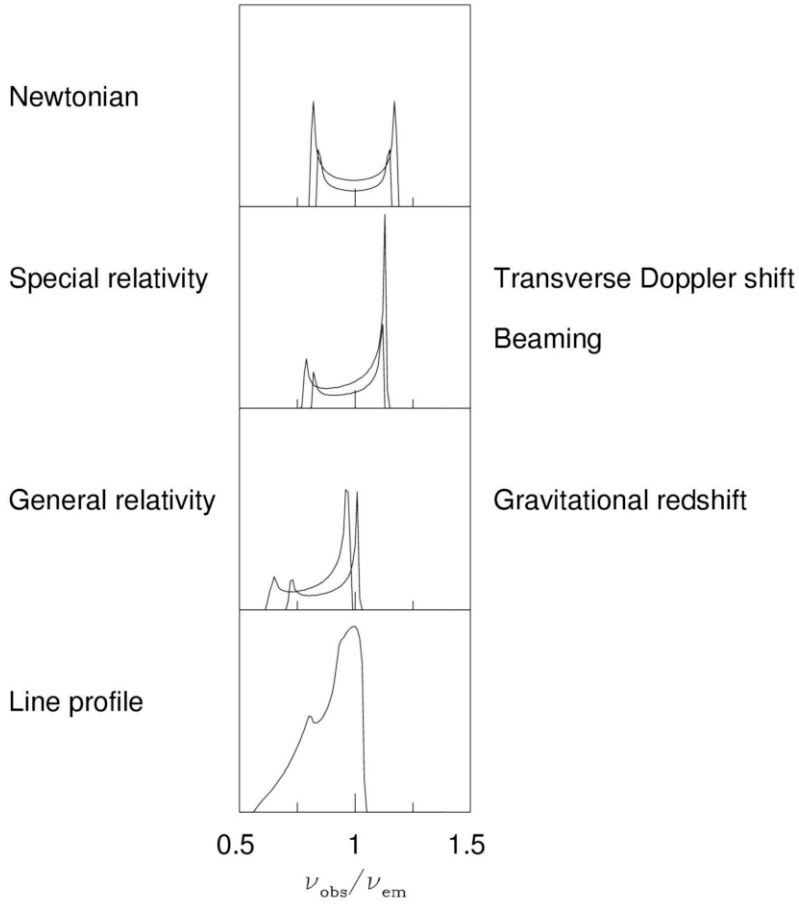


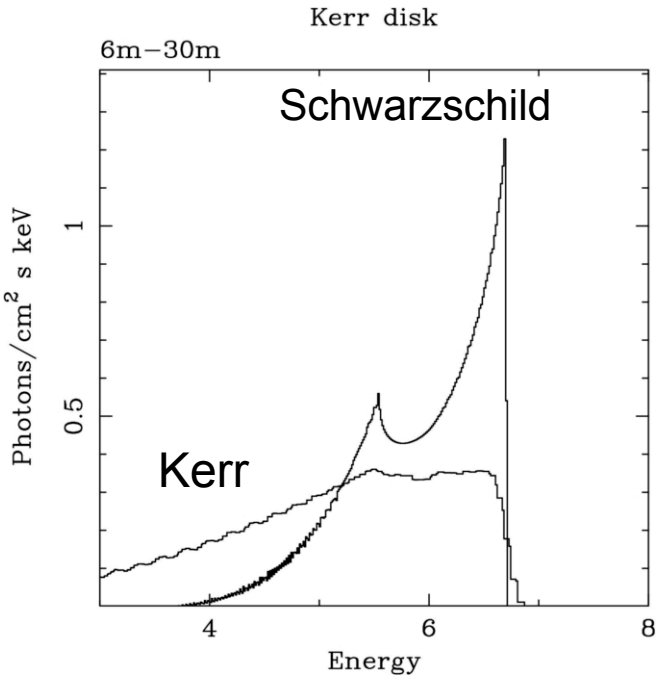


Emission dominated by innermost regions



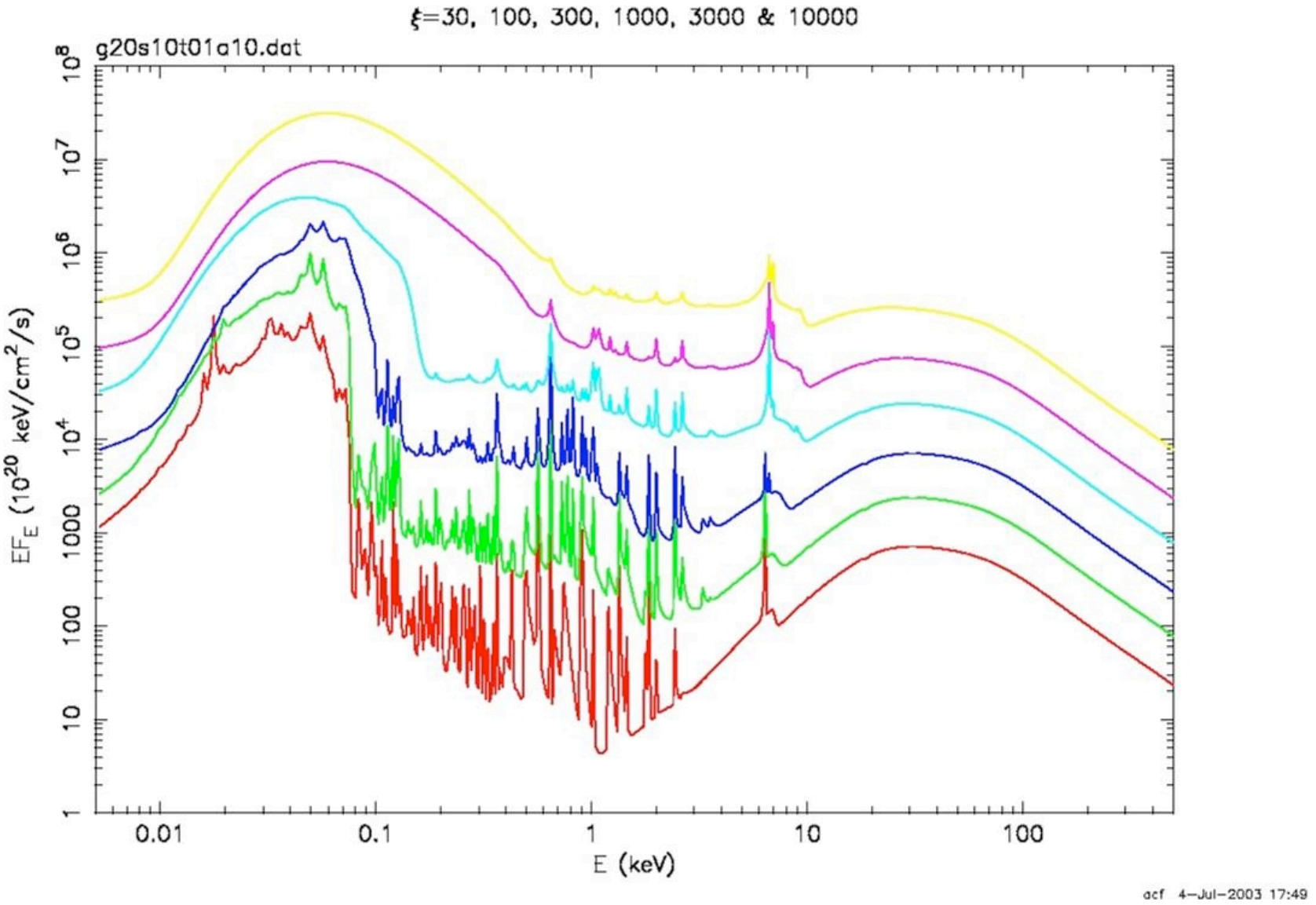


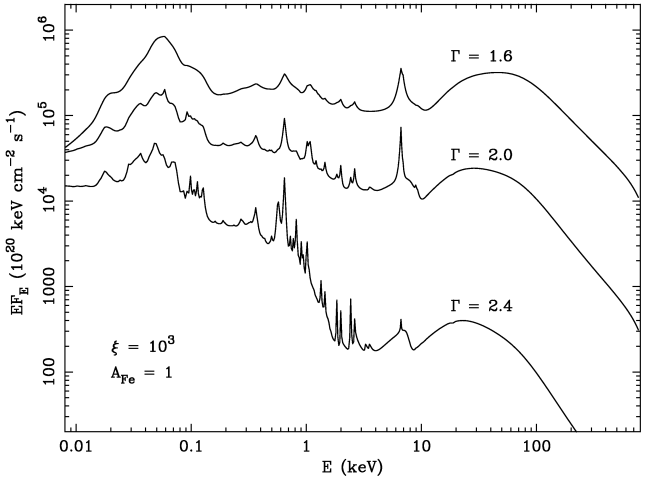

Newtonian
Special relativity
General relativity
Line profile
Transverse Doppler shift
Beaming
Gravitational redshift
0.5
1
1.5
ν_{obs}/ν_{em}


Kerr disk
6m−30m
Schwarzschild
Kerr
Photons/cm^2 s keV
0.5
1
4
6
8
Energy

Reflection from photoionized matter

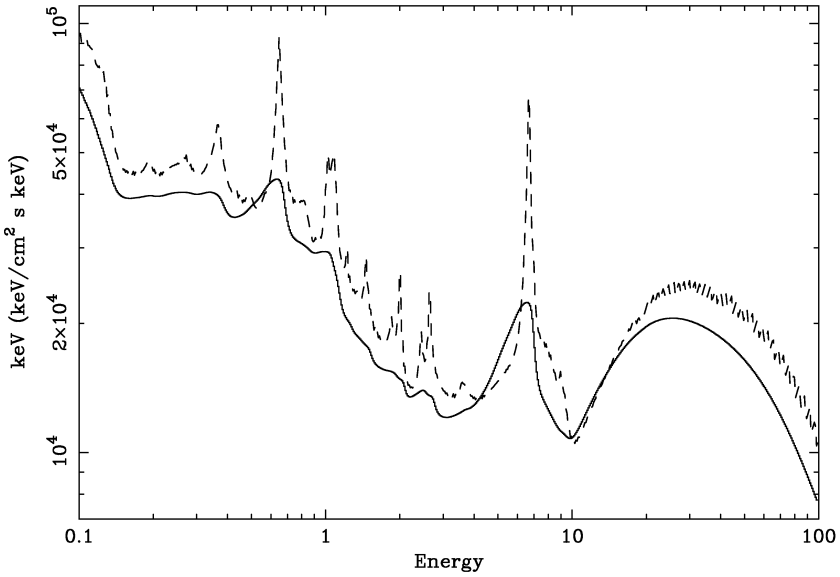
(Ross & Fabian 93, 04)

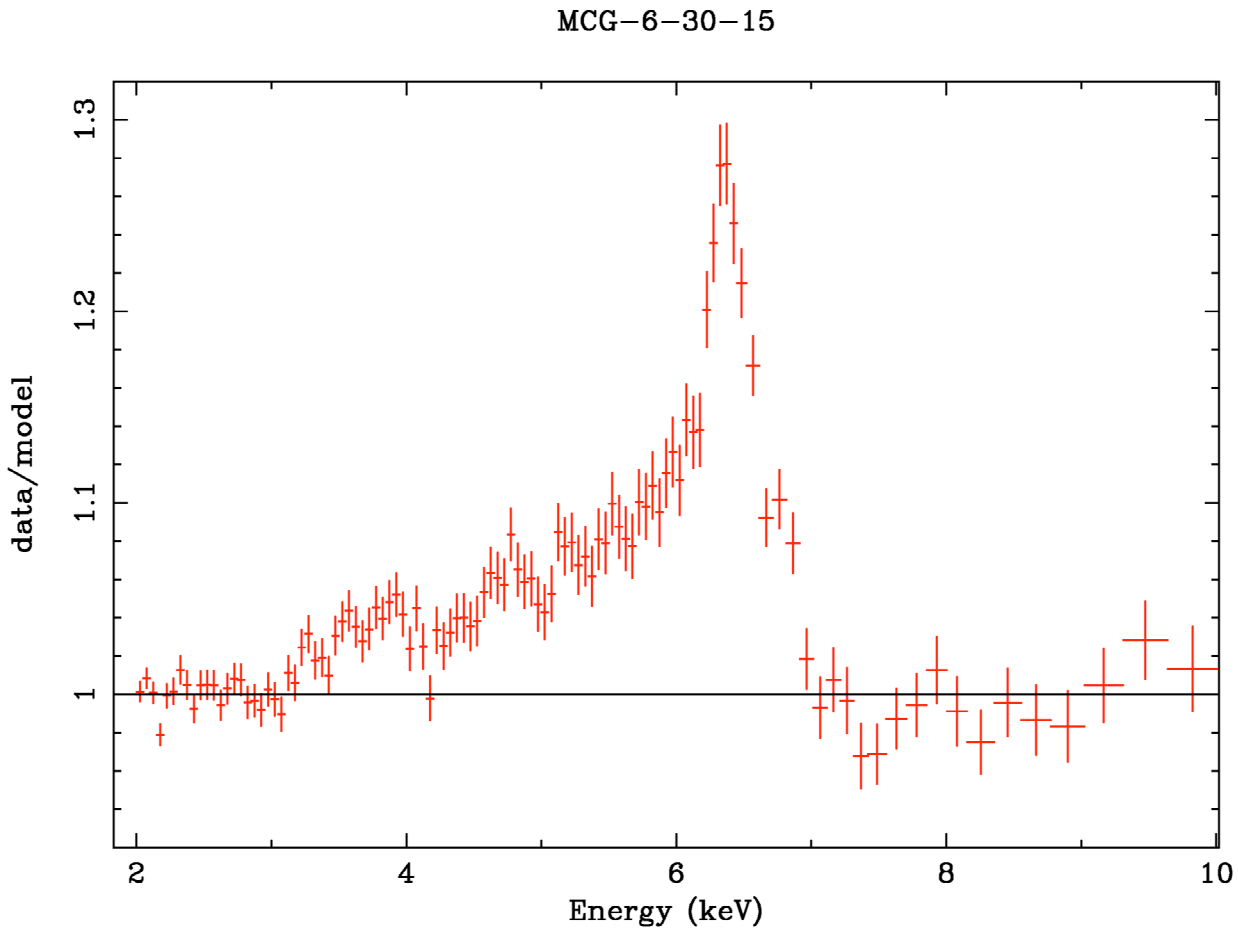




Vary spectral index

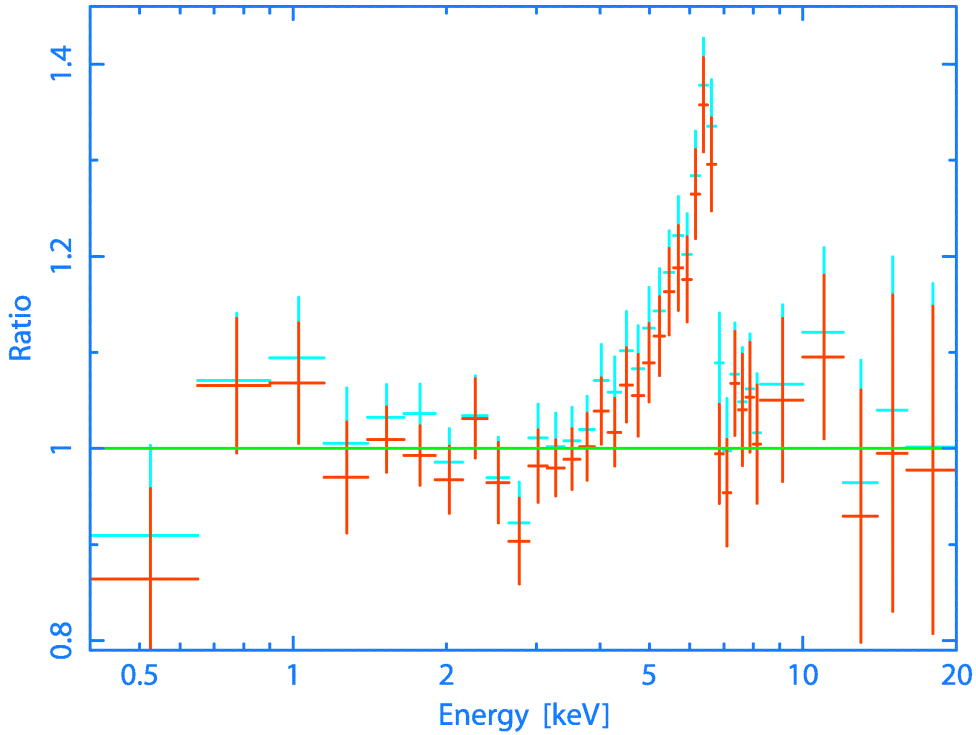
Add relativistic blurring





Very Broad Line ⇒ Spinning BH (more from Chris Reynolds)

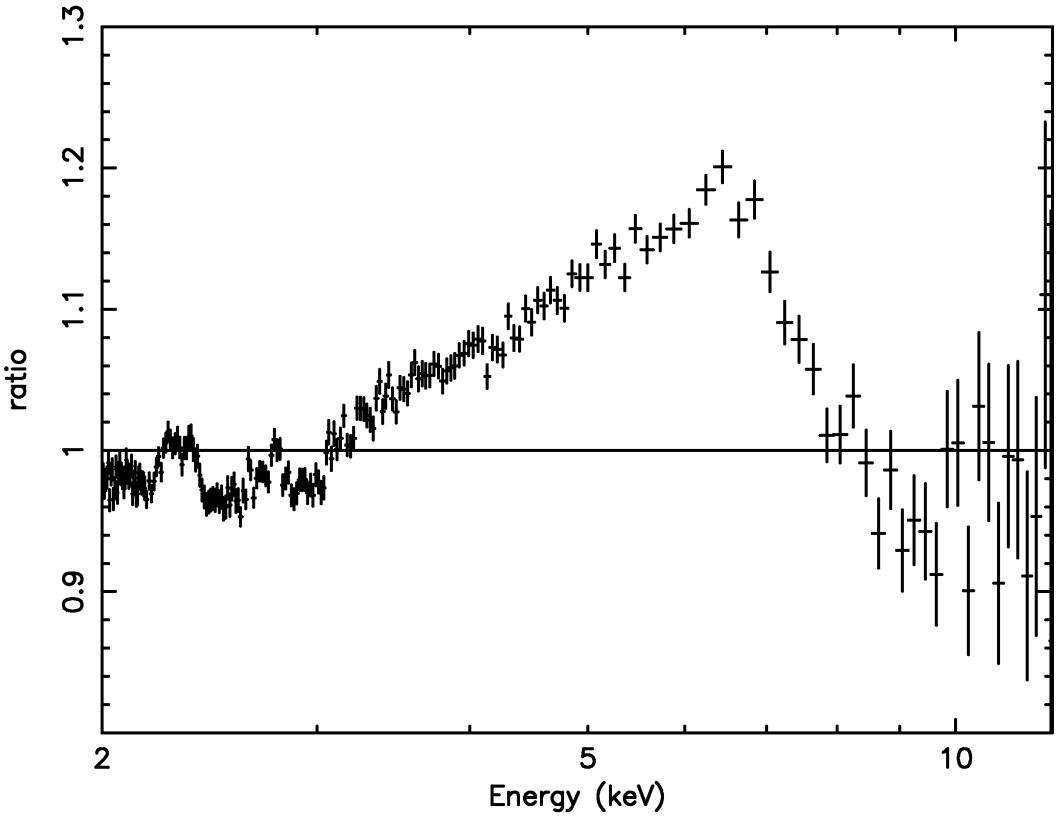
Broad Line ⇒ Probably spinning BHs



Stacked spectra of 53 Type I AGN Streblyanska et al (2005)

see Guenther Hasinger's talk

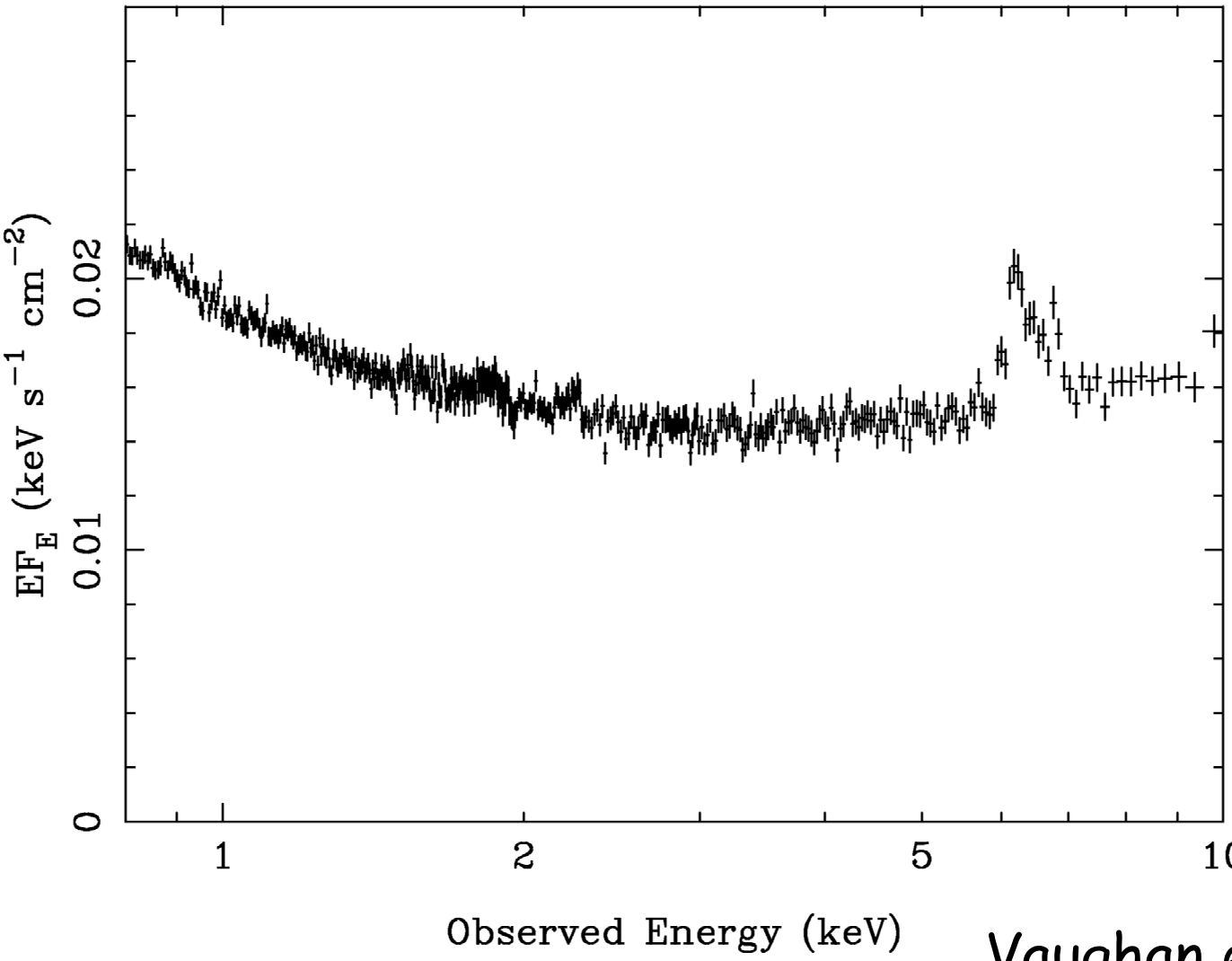
Galactic Black Hole GX339-4
see Jon Miller's talk



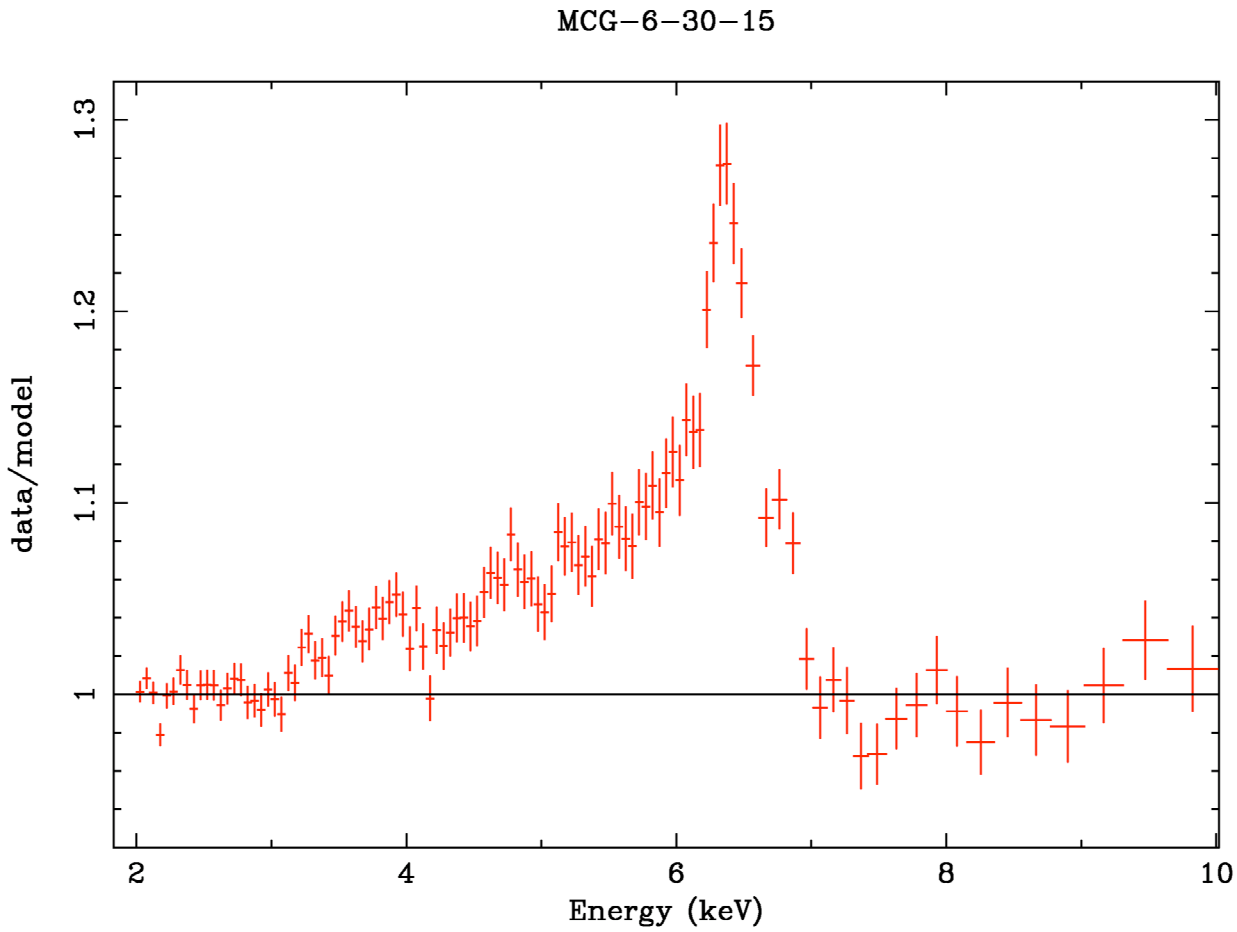
Very Broad Line ⇒ spinning BH

NO Broad Line

Ark 120

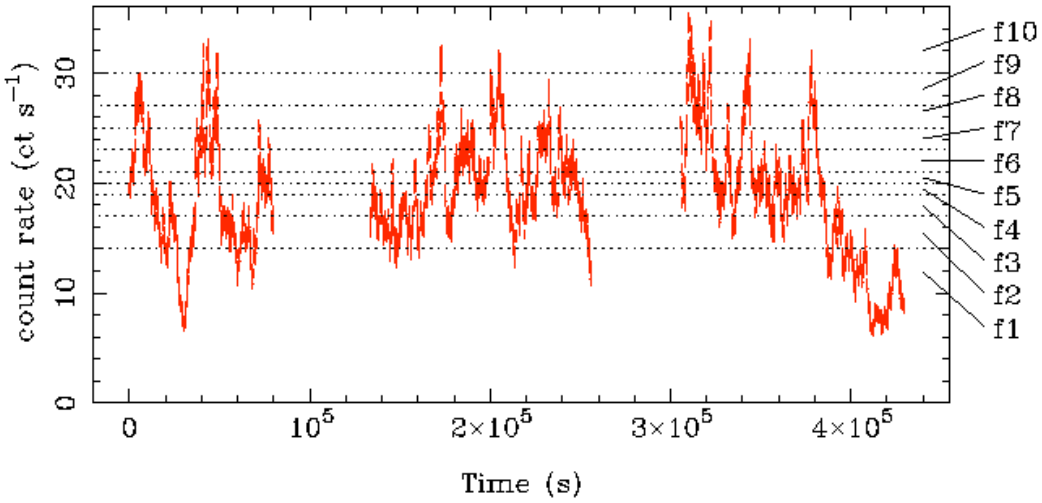


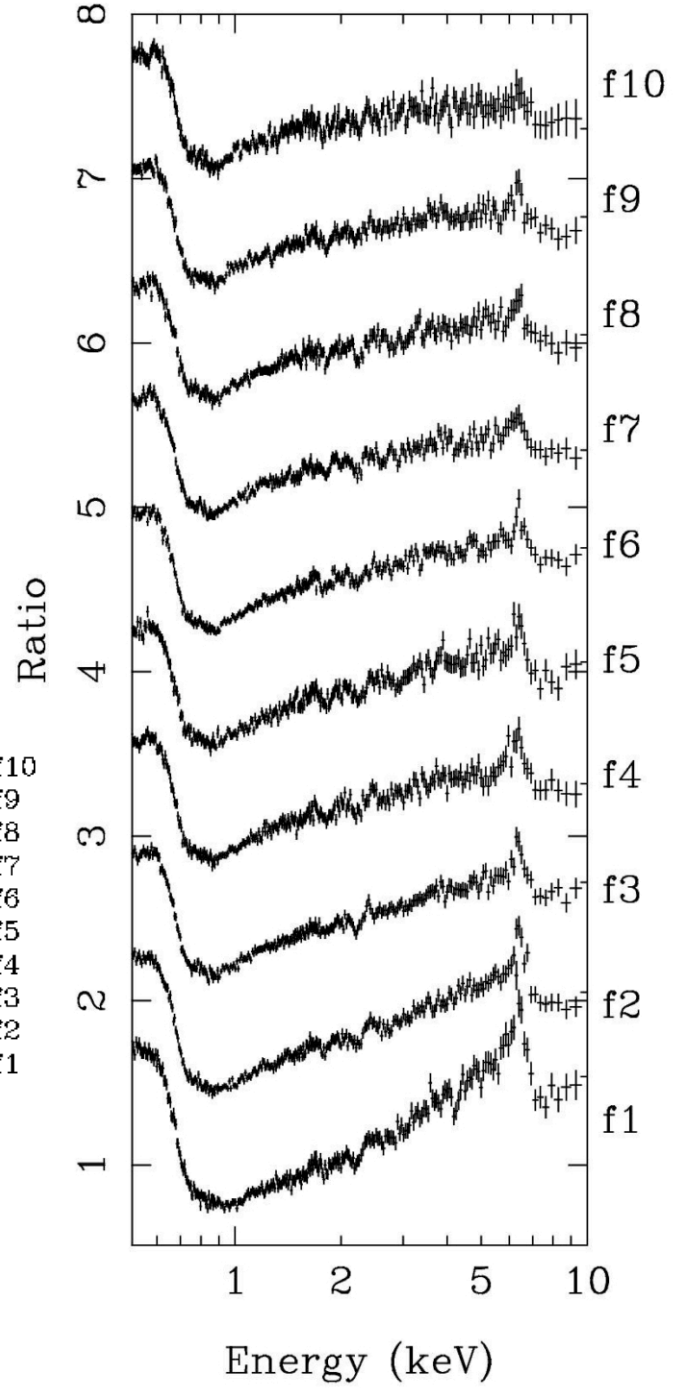
Vaughan et al 04



How does it vary?

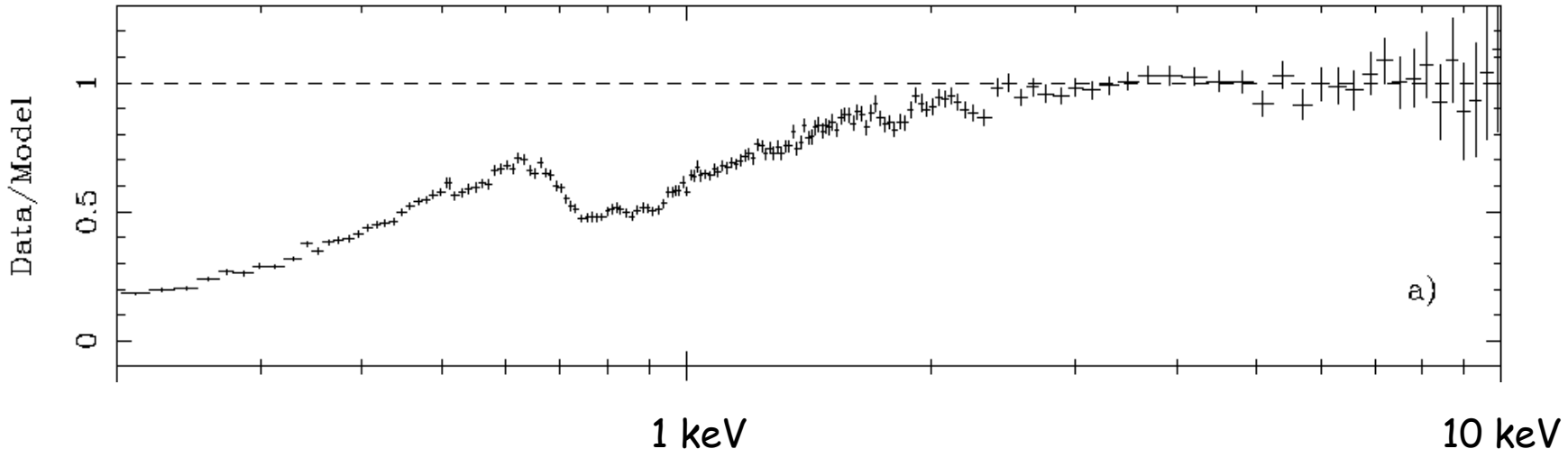
Spectral changes seen in 10 flux slices





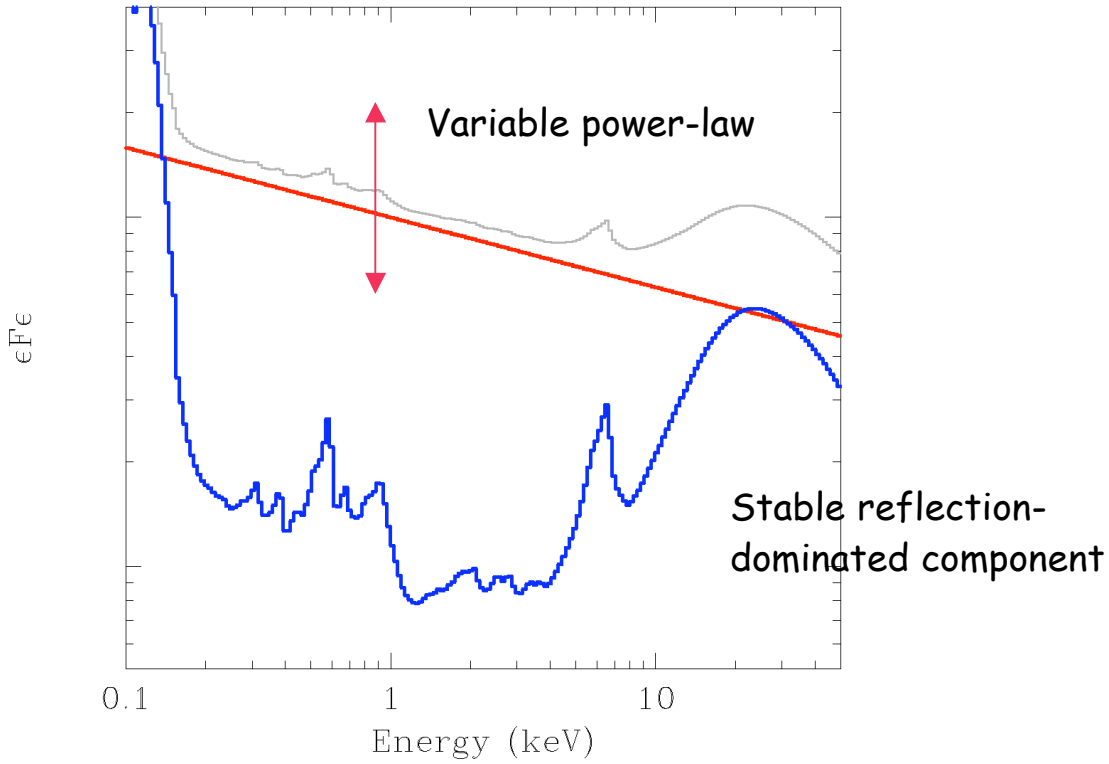
Difference spectrum: (High flux)-(Low flux)

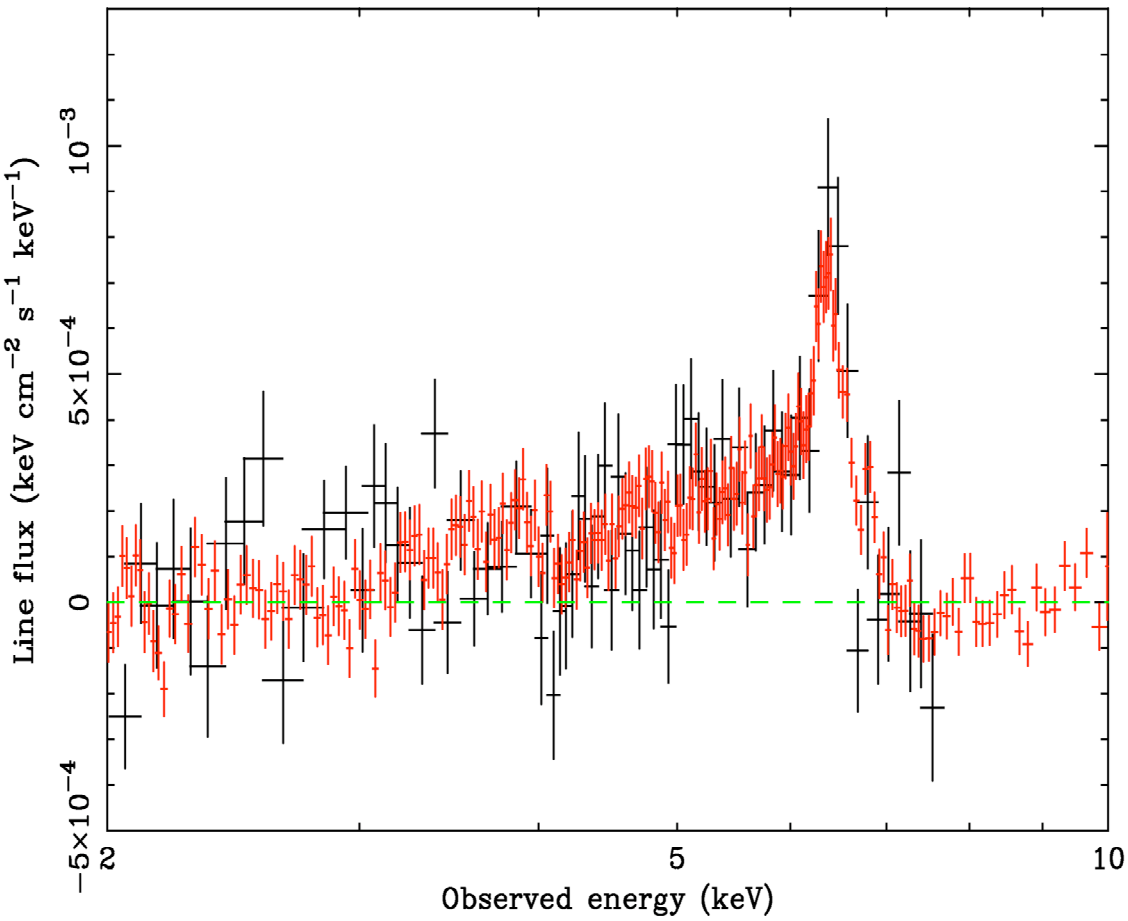
is a power-law modified by absorption



So we know which large scale features are due to absorption

Schematic picture of the two-component model

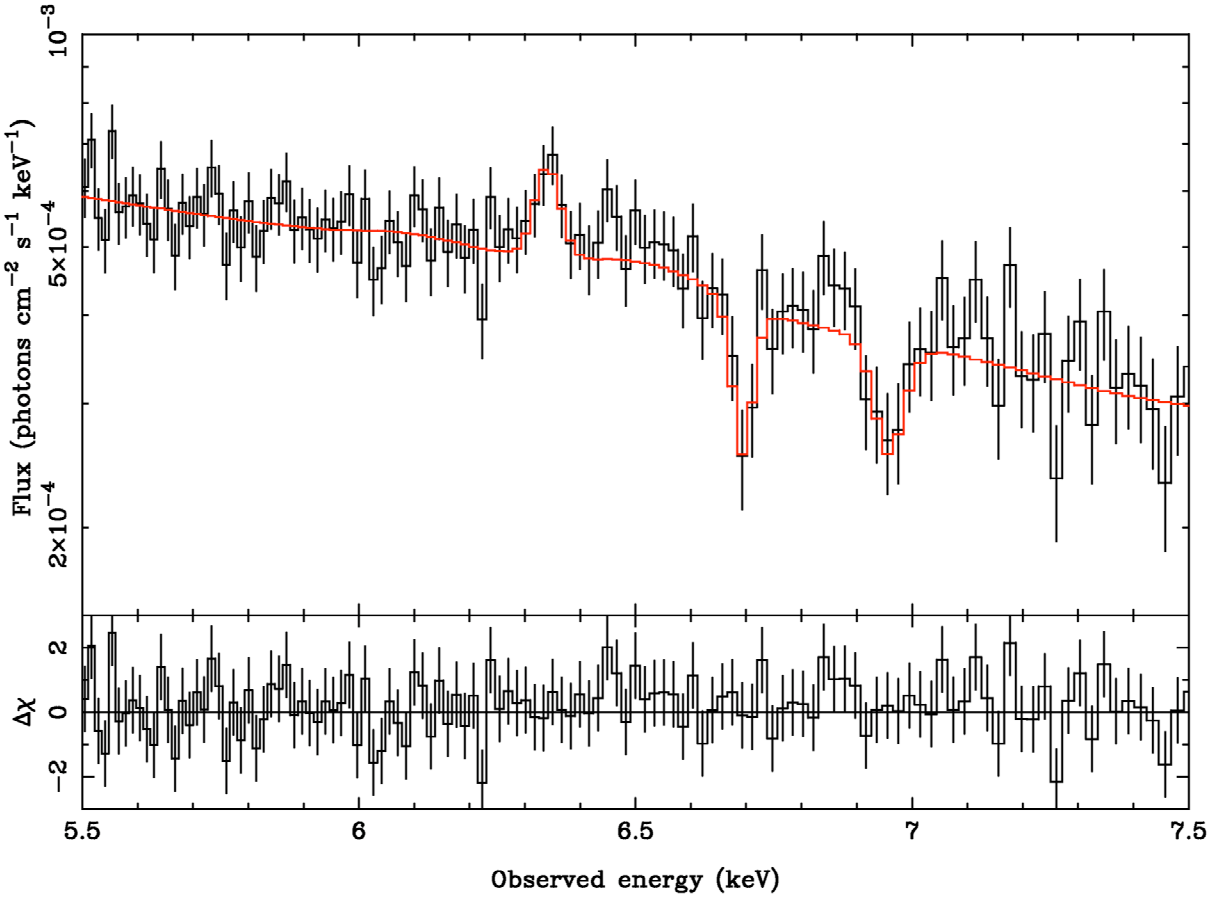




520 ks Chandra HEG observation of MCG-6-30-15

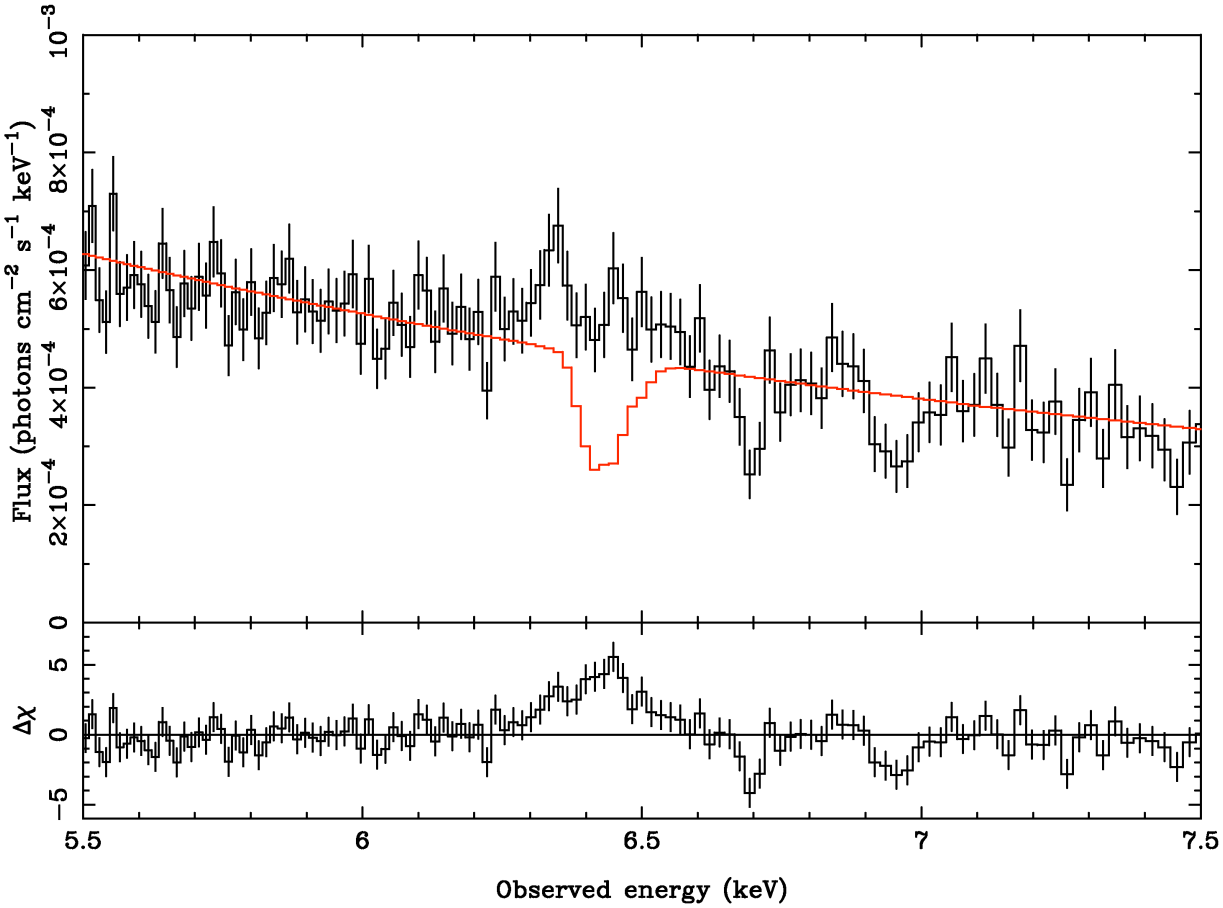
Young et al 2005 (submitted)

compared with XMM-Newton spectrum



Narrow Fe XXV and XXVI absorption found

v=2000 km/s blueshift



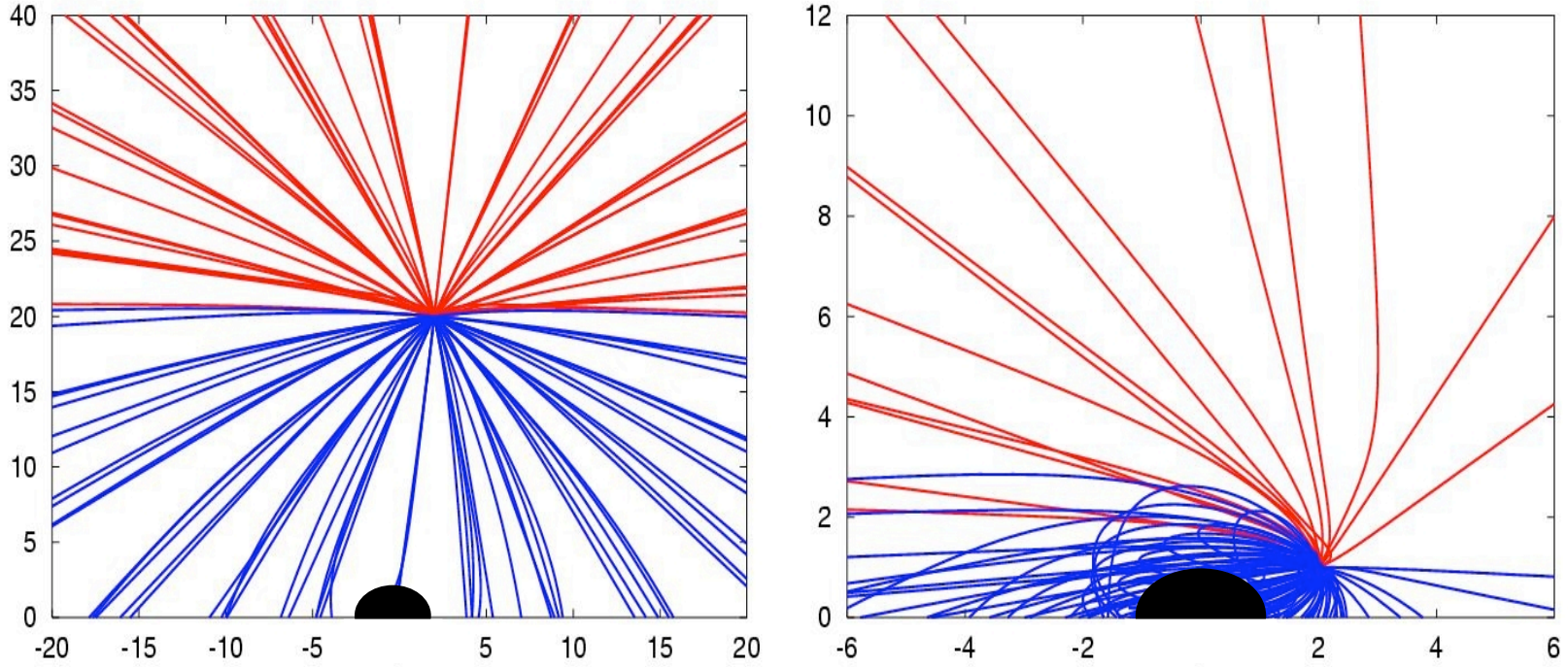
Constrains absorption by highly ionized species

(Wider discussion on absorption issues by Massimo Cappi)

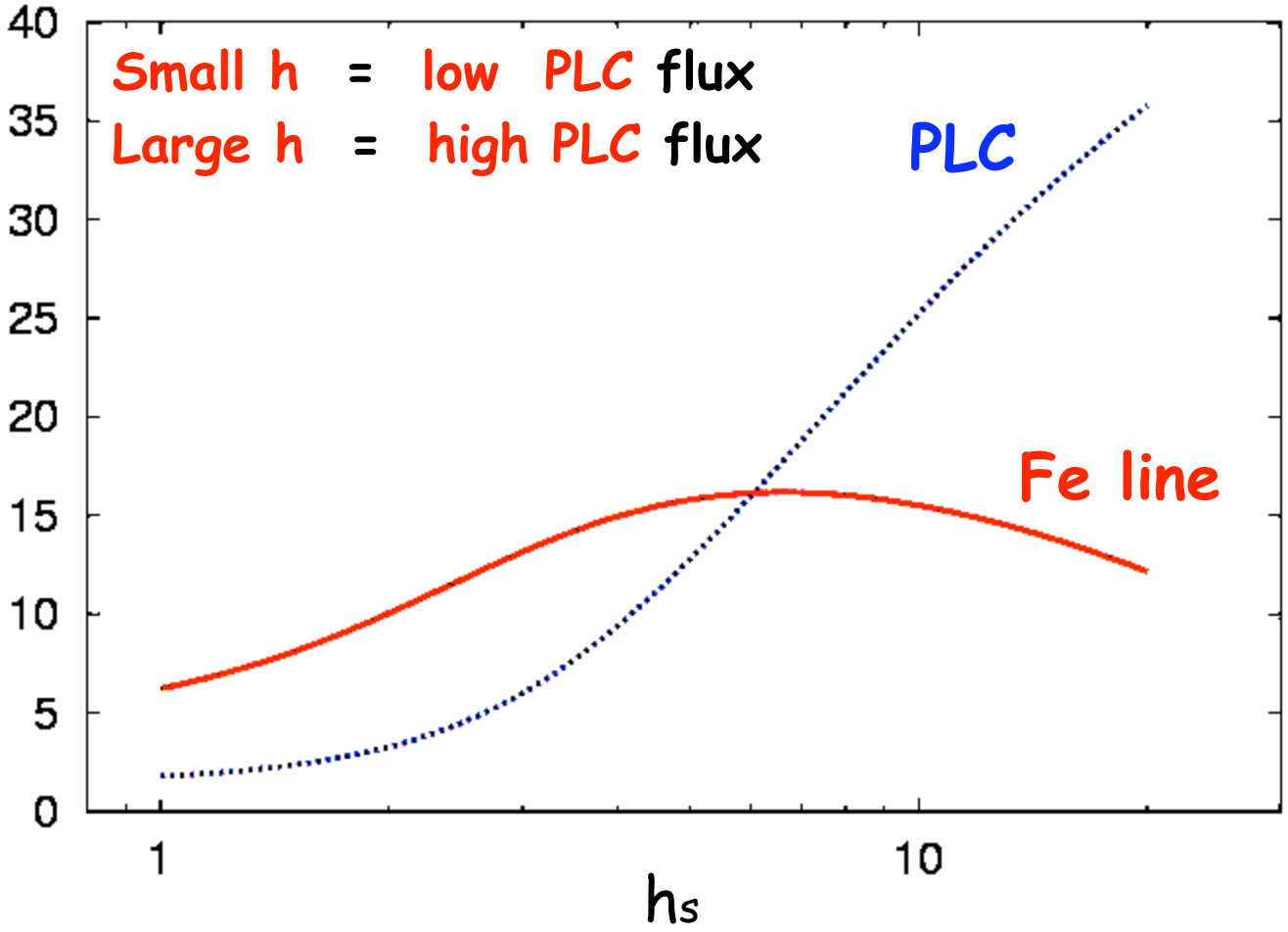
But, how can we produce a reflection-dominated spectrum in which the power law is only a minor contribution ?

How is this related to the extreme relativistic blurring that is required to describe the data ?

⇒ possible solution: the light bending model (Miniutti & Fabian 04)

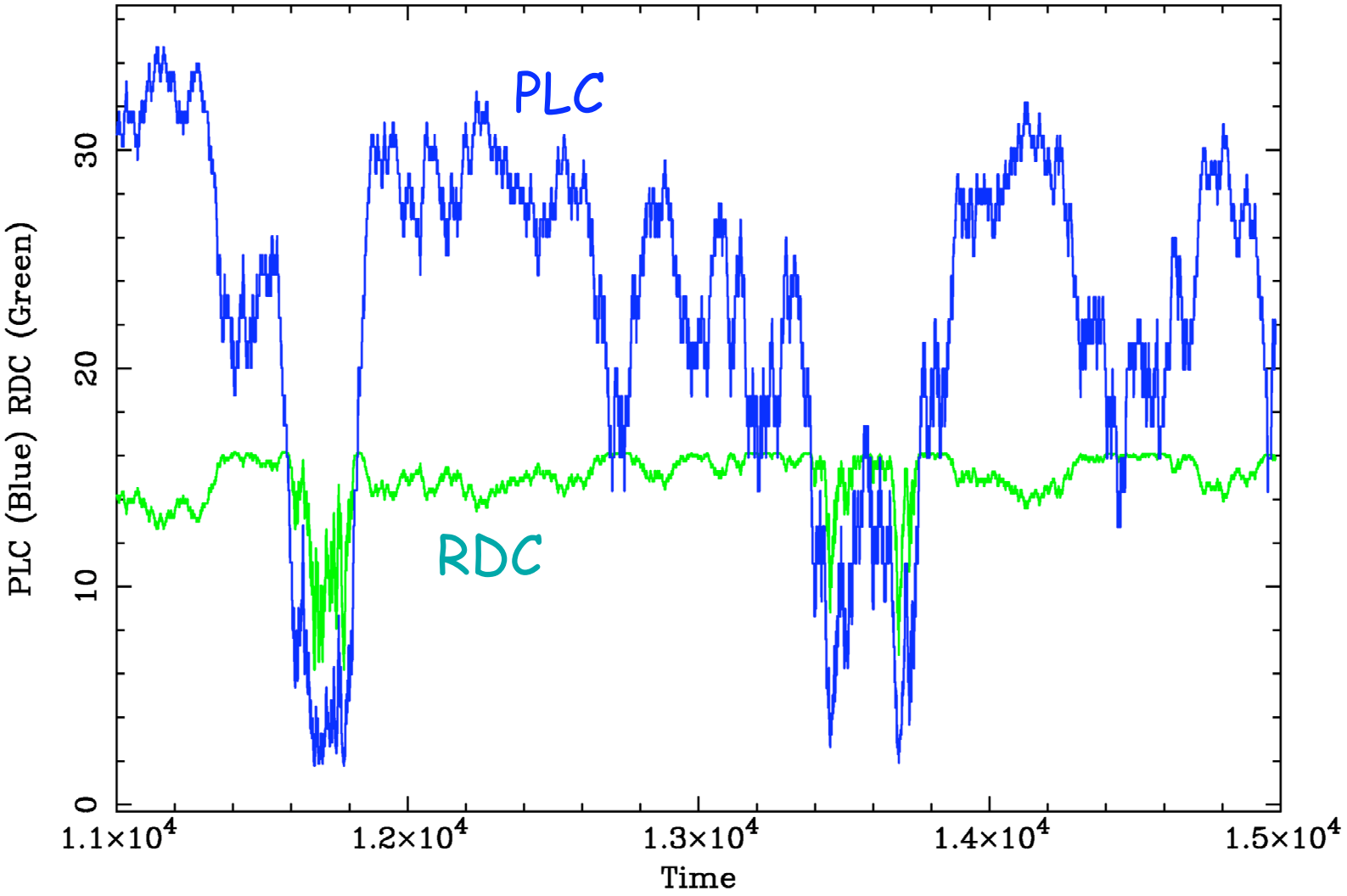


PLC and Fe line variability induced by light bending when an intrinsically constant source changes height

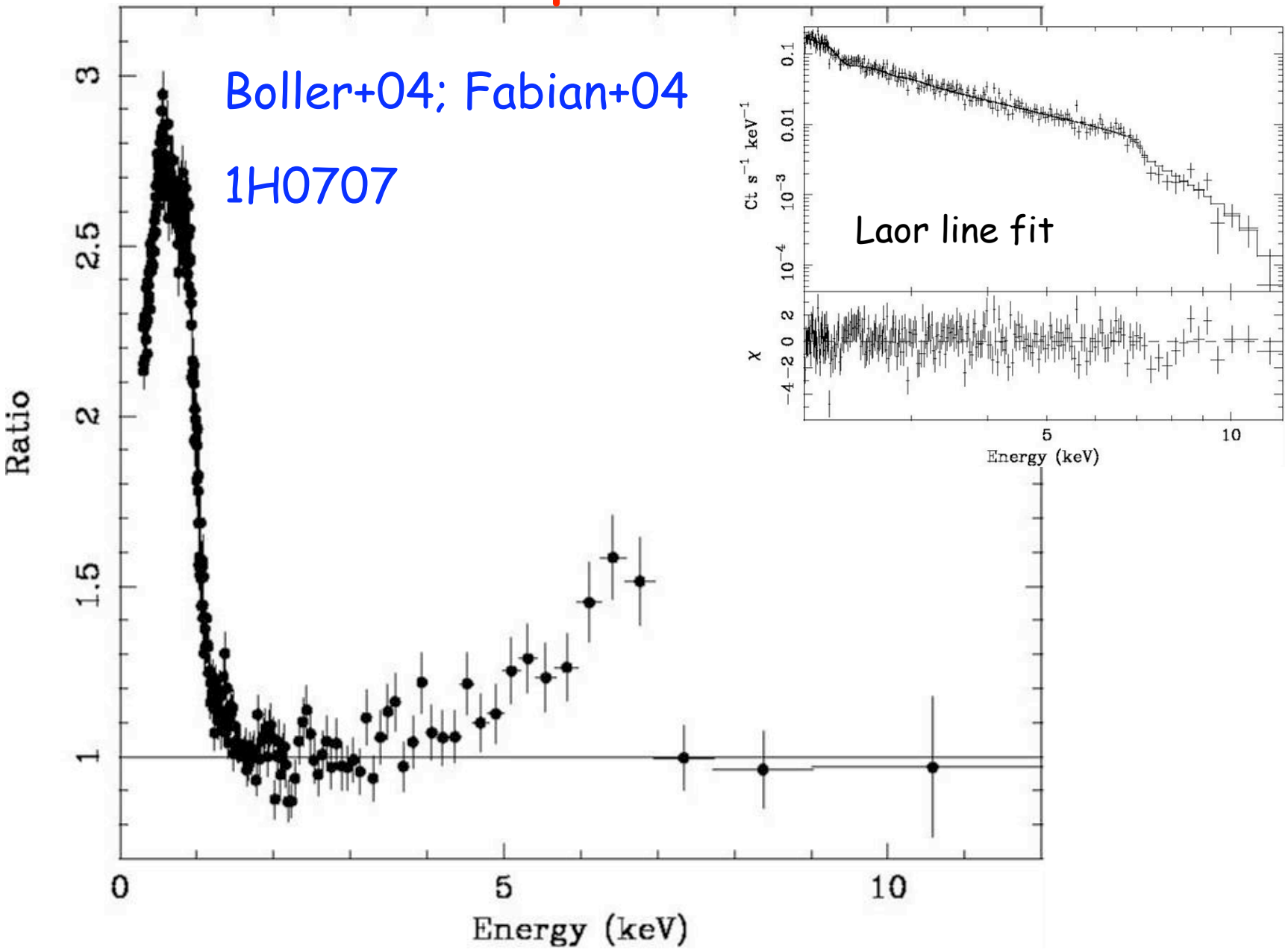


The Fe line varies with much smaller amplitude

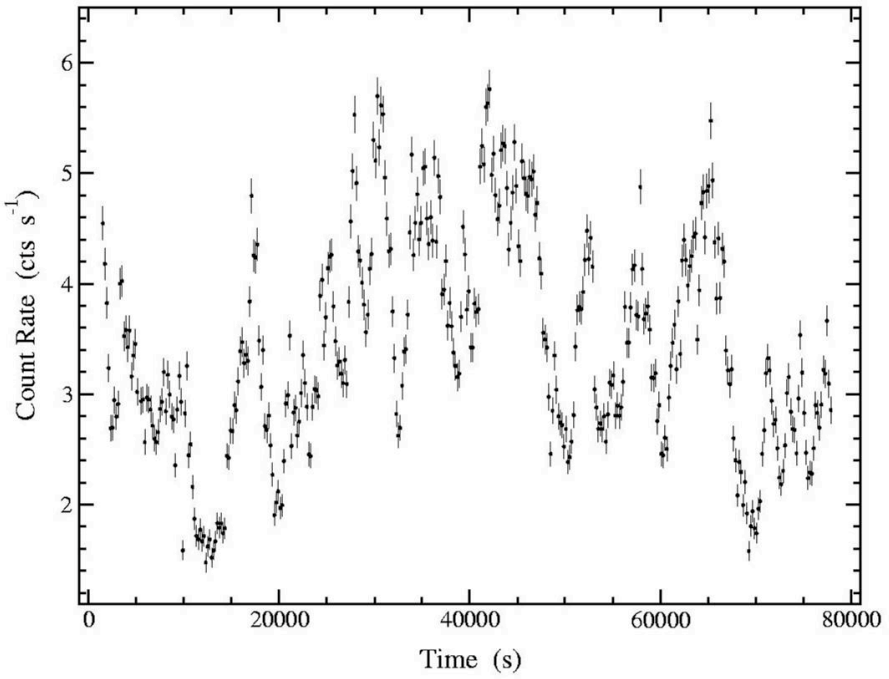
Simple height changing model

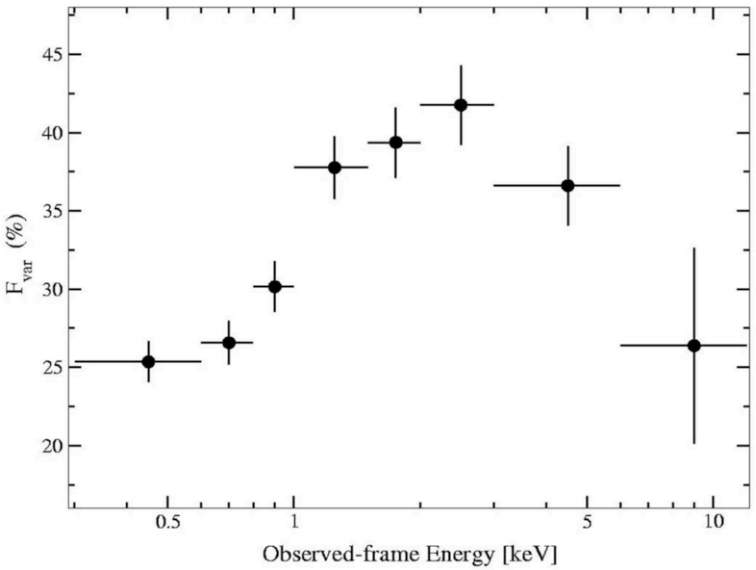


Is it absorption or a line?

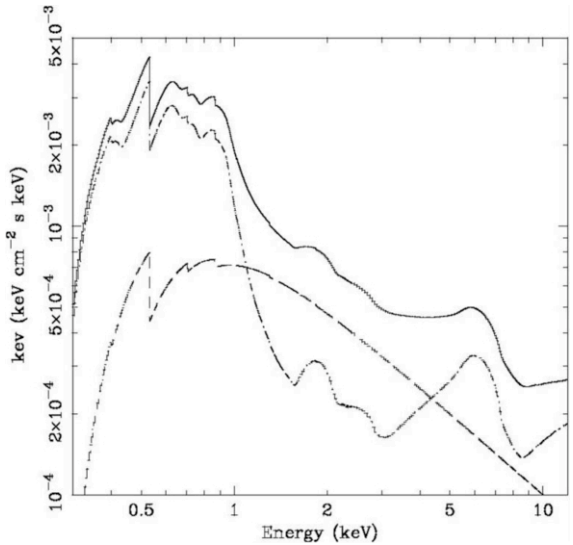


Variability

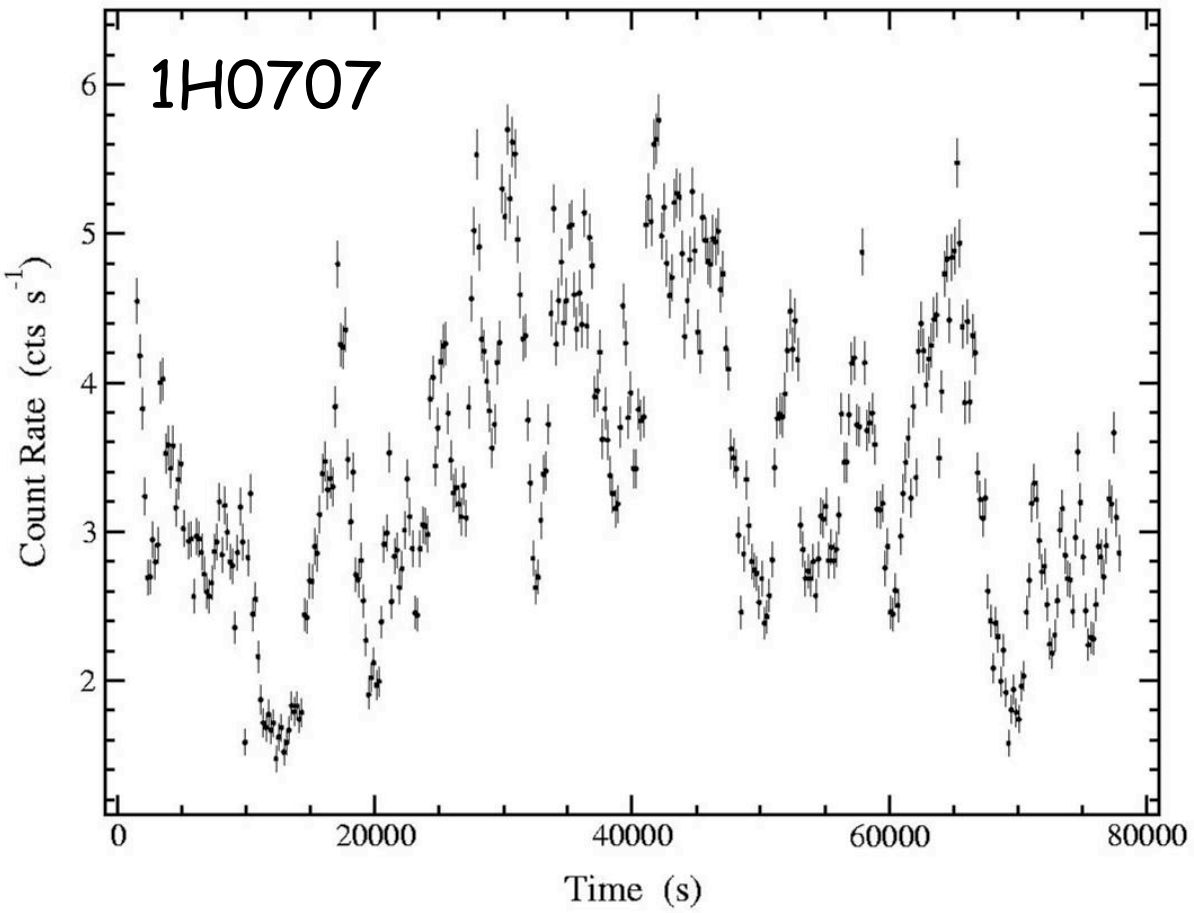


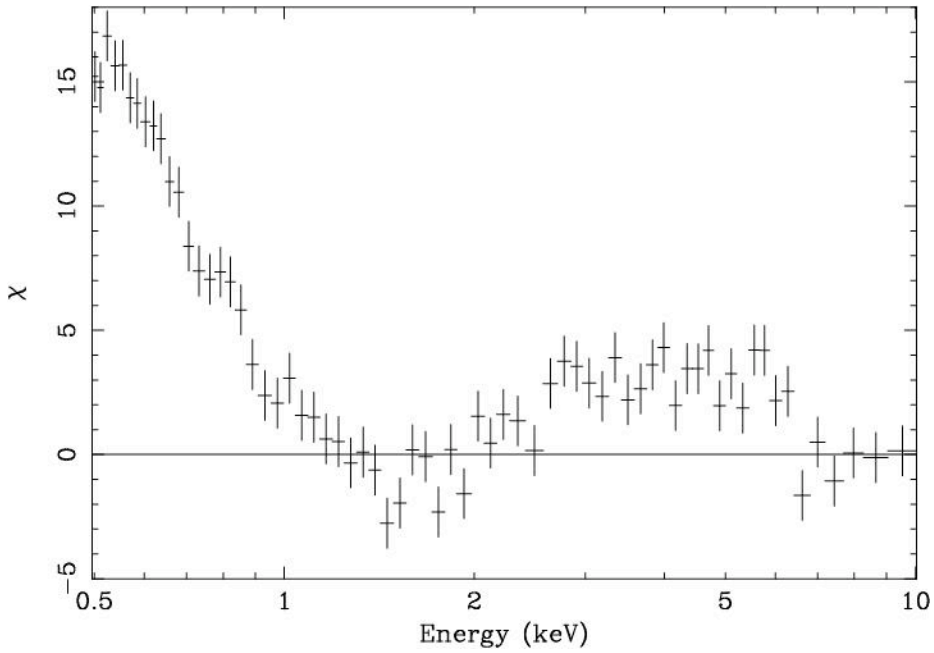


RMS fractional variability spectrum

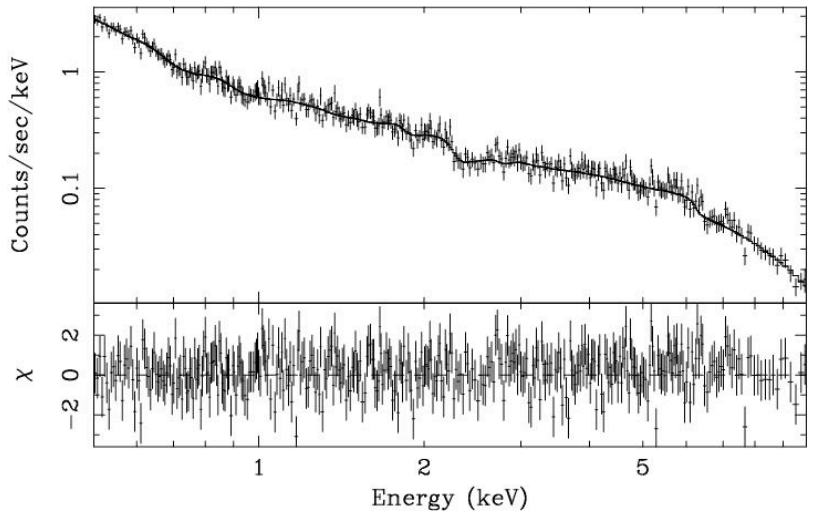


Rapid spectral variability of NLS1 explained if source within 6m



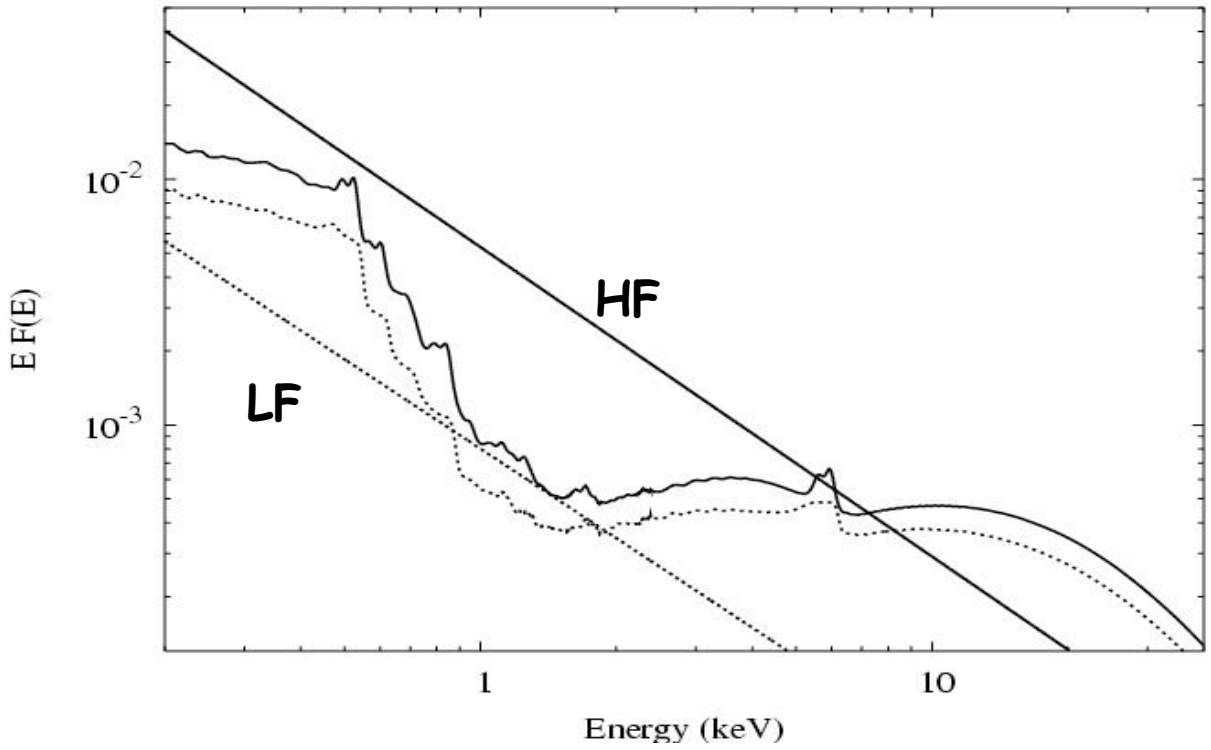


1H0439-577



Data from KA Pounds

(Fabian, Miniutti, Iwasawa & Ross 05)



In lowest state the spectrum is almost completely reflection-dominated

The reflection component requires strong relativistic blurring
(and implies the disc extends down to 2 grav radii)

Difference spectrum is power law

Conclusions on broad Fe line

- A consistent model for the broad iron lines
  seen in some Seyferts and BHC
- involves both
  - strong gravitational redshift
  - and light bending
- indicating that much of the reflection and thus primary emission is occurring within a few gravitational radii of the event horizon

- Good evidence from several objects that BH is spinning (Kerr solution necessary)

- (more on spin from Chris Reynolds)

The Future

- ASTRO-E2 – will sort out absorption vs emission structures
- NEXT – reflection humps
- Spectral Variability – reflection component in MCG-6 does vary on short timescales

  (Iwasawa+, Reynolds+, Ponti+) but difficult to characterize with XMM-Newton

XEUS / CON-X have the potential to maker MAJOR advances

Brightest lines are about 2 ph m^{-2} s^{-1}

Need sources with high L/L_{Edd} for broad lines (NLS1/GXRB)

Typically means

- BH mass of 10^6-10^8 Msun
- or timescales of 100s to 10^4s.

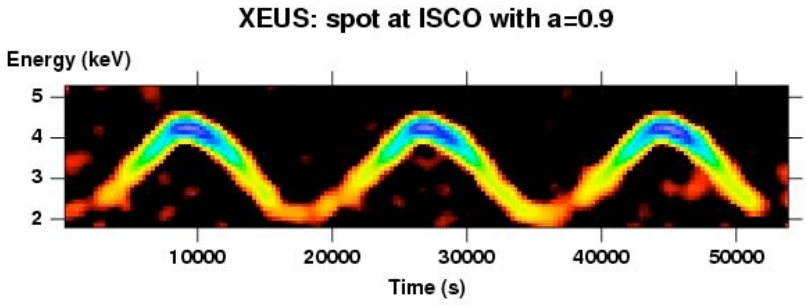
Therefore to study such BH on their

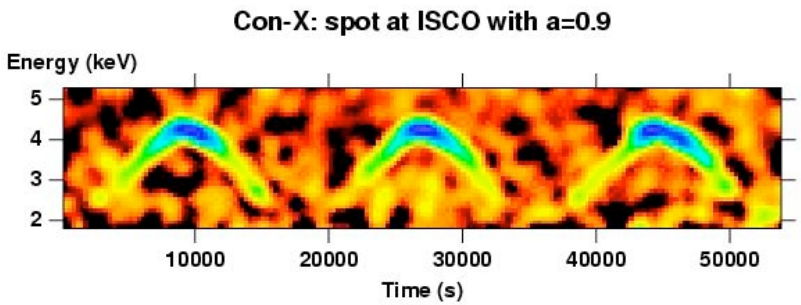
intrinsic variability

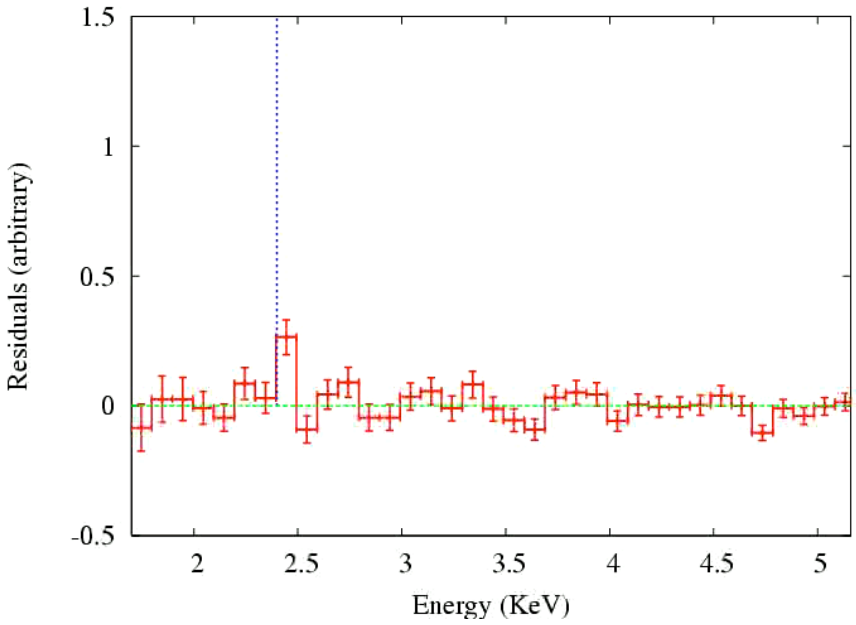
light crossing } timescales

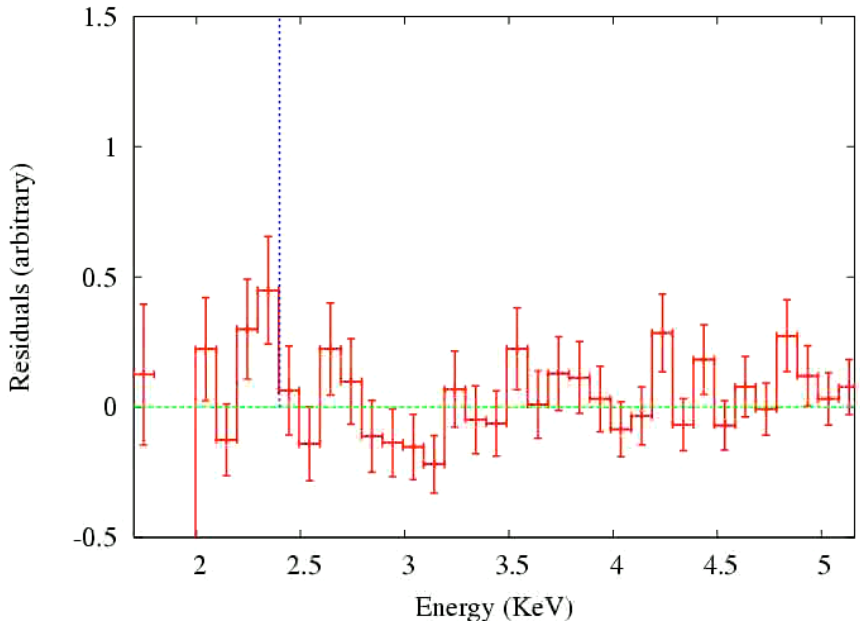
inner orbital period

→ effective collecting area at 6 keV of at least ~1m^2









F(2-10)=2x10^{-12}; M=1.2x10^{8}; i=30deg

Orbiting spot at 2.4r_g, P=18ks

Simulation by Giovanni Miniutti

The central engine of the
ACCRETING BLACK HOLE,

which is responsible for the MOST POWERFUL 'steady' sources in the Universe and is assuming a central role in GALAXY FORMATION,

is accessible to detailed study by

X-RAY OBSERVATIONS